Census of gulls and other seabirds along the coast of mainland Nova Scotia - 2002

Andrew W. Boyne and Jason T. Beukens

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CENSUS OF GULLS AND OTHER SEABIRDS ALONG THE COAST OF MAINLAND NOVA SCOTIA - 2002

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INTRODUCTION

In Nova Scotia, the last province-wide gull survey was conducted in 1987 (Lock, unpublished data). Aside from extrapolations made from neighbouring states and provinces and scattered data from some colonies (e.g. Boot Island; C. M. Mackinnon, Canadian Wildlife Service – Atlantic Region, unpublished data), little is known about the status of the gull population in Nova Scotia since that survey. This is disconcerting as gulls are considered one of the most significant threats to the Endangered Roseate Tern (*Sterna dougallii*) (Whittam 1999). The majority of the Canadian population of Roseate Terns nests in Nova Scotia and managing gull predation is a key component in the recovery strategy for the species. Furthermore, in the last fifteen years many landfills have been closed (Nova Scotia Department of the Environment 2000) and fisheries activities have been reduced in much of the province as a result of quota reductions and moratoriums. Both of these human activities likely provided foraging opportunities for gulls (Nisbet 1978, Hunt 1972). The impacts of these landscape changes on the provincial gull population are unknown.

In north eastern North America, populations of Herring Gulls (*Larus argentatus*) and Great Black-backed Gulls (*L. marinus*) increased dramatically during the 20th century (Kadlec and Drury 1968). This growth was likely initiated by the passing of bird conservation laws, such as the Migratory Bird Convention Act (1918). During the first 50 years of the 20th century, seabird populations recovered from decades of market hunting and exploitation for plumes, eggs, and meat (Kadlec and Drury 1968). Herring and Great Black-backed Gulls had the added benefit of being opportunistic generalist foragers (Good 1998, Pierotti and Good 1994), able to capitalize on anthropogenic food sources such as fisheries discards and garbage, the availability of which increased as the human population and activity expanded along the coast (Nisbet 1978).

Increasing populations of large *Larus* gulls impacted other species of seabirds, most notably terns, as both gulls and terns prefer to nest on offshore islands with minimal vegetation. The impact of gulls on terns is twofold; they prey on tern adults, chicks, and eggs, but they also arrive at the breeding islands several weeks prior to terns and exclude them from nesting sites (Kress et al. 1983).

Recent surveys in eastern Canada, suggest that populations of large *Larus* gulls, particularly Herring Gulls, are declining (Boyne and Hudson 2002, Boyne et al. 2001, Mawhinney et al. 1999, Chapdelaine 1995, Hebert 1989). Many of these declines were recorded after the early 1990s when the ground fish moratorium was placed on the fisheries of eastern Canada. During this same period many local landfills and dumps were replaced with larger regional waste management facilities which reduced the amount and availability of exposed garbage. Despite recorded declines in gull populations, gulls are still consistently mentioned as a threat to seabird populations (Kress and Hall *in prep*, Milko et al. 2003, United States Fish and Wildlife Service 1998). It is difficult to speculate the degree to which gulls may threaten seabirds, including the Endangered Roseate Tern in Nova Scotia, without knowing their current distribution and abundance.

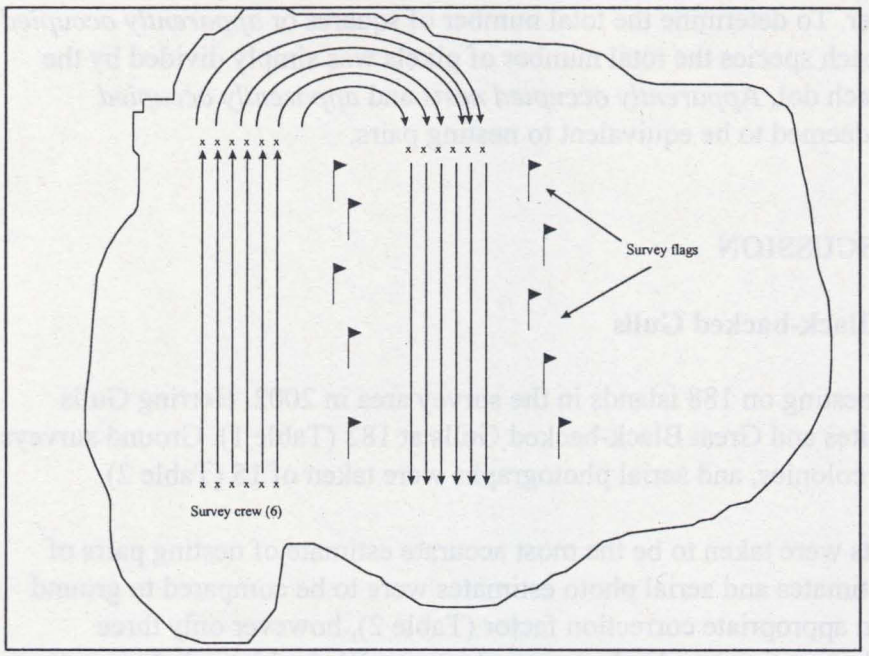
This report contains the results of a survey for Herring and Great Black-backed Gulls conducted in mainland Nova Scotia in 2002. Additional data on breeding cormorants (*Phalacrocax auritus* and *P. carbo*), Great Blue Herons (*Ardea herodias*) and Common Eiders (*Somateria mollissima*) are also presented.

METHODS

In 2002, an aerial survey of the coast of mainland Nova Scotia was conducted on 23 May from Hartlen Point (N 44.589°, W 63.452°) west to Truro (N 45.368°, W 63.285°), and on 24 May from Fox Harbour (N 45.847°, W 63.447°) east to Hartlen Point. A section of coastline between Pubnico Point (N 43.592°, W 65.802°) and Chebogue Point (N 43.735°, W 66.120°) was skipped on 23 May because of low fuel and was subsequently flown on 11 June, 2002 (Figure 1). Cape Breton and the coast from Truro to the New Brunswick border and from the New Brunswick border to Fox Harbour were not surveyed because of time constraints, and Seal Island (N 43.409°, W 66.015°) and the Mud Island archipelago (N 43.485°, W 65.989°) off south western Nova Scotia were not surveyed because of regulations prohibiting the use of a single-engine plane at low altitudes offshore.

Two observers (23-24 May - AWB and A. R. Lock, CWS Atlantic Region; 11 June - AWB and JTB) conducted the survey from a Cessna 172 (23-24 May - Truro Flying Club, pilot: Terri Goiziou; 11 June - Shearwater Flight Centre, pilot: Savina Kashyap) flying at 400 - 800 feet at ~80 knots. Observer 1 sat in the front right-hand seat and Observer 2 in the rear right-hand seat. Bird colonies were identified from the air, and their location marked on 1:250,000 topographic maps or, in areas with high island densities, on 1:50,000 topographic maps. On islands with small populations total counts of individual gulls and other seabirds were performed, but at larger colonies birds were counted in clusters of 5, 10 or 25. Birds that were obviously loafing, on the edge of the colony, or in the intertidal zone were not counted. Counts were conducted by both observers. On islands with both Great Black-backed Gulls and Herring Gulls an attempt was made to count both separately, however for larger colonies a species ratio was estimated. In addition, aerial photographs were taken of a subset of gull, cormorant, and heron colonies from the opened right passenger-side window of the plane at an altitude of ~600 feet. The angle of photographs varied depending on island size and the height of the aircraft. Photos were taken with a Pentax 645 medium format camera with Kodak professional E100S Ektachrome colour reversal film.

A subset of gull colonies was subsequently visited by a survey crew to obtain nest counts. Ground surveys were conducted from 16 May - 5 June, 2002. Surveys were conducted with 2-5 researchers walking parallel transects about arms length apart. The outside line of each transect was marked with forestry survey flags, which were picked up on the following transect (see box on page 3). The number of eggs and chicks was recorded for each nest. The species attending each nest was determined by a combination of egg size,



Pattern of ground surveys for gulls in Nova Scotia, 2002

nest location, direct observation of incubating birds, and hatching chronology. Since Great Black-backed Gulls nest 1-2 weeks earlier than Herring Gulls (Erwin 1971, Harris 1964) any nest with chicks was deemed to be a Great Black-backed Gull nest, except at Devil's Island where Herring Gull nests had also started to hatch. On islands where chicks were old enough to have wandered far enough that it was not possible to associate them with particular nests, the total number of nests, eggs, and chicks were recorded separately. This permitted the estimation of percent hatch but did not permit the determination of clutch sizes.

Aerial photographs of gull, cormorant and heron colonies were interpreted digitally (Chardine 2000). Films were scanned to Pro-CDs at a resolution of 6144 x 4096 pixels and analyses were performed using Adobe Photoshop® 5.5. For islands too large to be captured on one photograph, multiple overlapping photos were taken. These photographs were put together in Photoshop to create a single image of the entire island. In Photoshop, a layer was added for each species and using the pencil tool a square, with a known number of pixels, was placed on each *apparently occupied territory* (gulls) or *apparently occupied nest* (herons and cormorants; Walsh et al. 1995). The number of pixels in a square varied between photos depending on the zoom level that was optimal to identify nests.

It was possible to identify *apparently occupied nests* for cormorants and herons because their nests are of sufficient size to be detectable on the photographs. However for gulls it was only possible to identify *apparently occupied territories*. Individual gulls or pairs on the interior of the colony that were spaced regularly were assumed to be on territories. Gulls that were obviously loafing, on the edge of the colony, or in the intertidal zone were not included in the count. The number of *apparently occupied nests* and *apparently occupied territories* was determined using the HISTOGRAM function in Photoshop. This produced a histogram with the number of pixels of each colour on a layer. Since there is only one colour on the layer for a particular species only one bar appears on the histogram. By placing the cursor over the bar Photoshop shows the number of pixels of

that colour on the layer. To determine the total number of squares or *apparently occupied nests/ territories* for each species the total number of pixels was simply divided by the number of pixels in each dot. A*pparently occupied nests* and *apparently occupied territories* were both deemed to be equivalent to nesting pairs.

RESULTS AND DISCUSSION

Herring and Great Black-backed Gulls

Gulls were observed nesting on 188 islands in the survey area in 2002. Herring Gulls were observed at 78 sites and Great Black-backed Gulls at 182 (Table 1). Ground surveys were conducted at 11 colonies, and aerial photographs were taken of 15 (Table 2).

Ground counts of nests were taken to be the most accurate estimate of nesting pairs of gulls. Aerial visual estimates and aerial photo estimates were to be compared to ground counts to determine an appropriate correction factor (Table 2), however only three colonies with aerial photo estimates also had ground counts. We had intended to conduct more ground surveys, however time constraints and poor weather limited the number of colonies we were able to visit. Because of the small sample size it was not possible to derive a correction factor using aerial photo estimates so it was derived using the most precise visual estimate of the two aerial observers. The aerial visual estimate of Observer 1 (AWB) was the most precise (1.31 nests [ground counts]/ individual [aerial estimate]; 1.20-1.42: 95% Confidence Interval [CI], N = 10; Table 2), while Observer 2 (A.R. Lock and JTB) was the most accurate but the precision was lower (1.23 nests/ individual [1.02-1.44: 95% CI, N = 10). Furthermore, the use of Observer 1's estimates simplified the development of a correction factor because they provided an estimate for each colony. Poor visibility from the rear seat limited the second observer's estimates to 177 of the 188 gull colonies (Table 1).

To estimate the total number of breeding pairs of gulls for each colony, the number of individuals estimated visual from the air by Observer 1, was multiplied by 1.31 (1.20-1.42: 95% CI; Table 1). For large colonies where it was not possible to count Great Black-backed Gulls and Herring Gulls separately, the mean species ratio of the two observers for each colony was used to calculate the number of each gull species. Using this methodology we estimate that there were 11393 pairs (10476-12342: 95% CI) of Great Black-backed Gulls and 6434 pairs (5844-6970: 95% CI) of Herring Gulls nesting in the study area. One key site on mainland Nova Scotia was not surveyed. Brier Island (N 44.252°, W 66.368°) was overlooked as we headed back to the airfield because of low fuel. The omission is serious because this colony had 4235 pairs of Herring Gulls and 313 pairs of Great Black-backed Gulls in 1987 (A.R. Lock, unpublished data)[1] and 2000 pair of Herring Gulls and 400 pairs of Great Black-backed Gulls in 1971 (Lock 1971)[1]. If this

[1] Data from Lock (unpublished data and 1971) were corrected using the ratio of 1.266 territorial gulls counted on photos to number of nests counted on the ground and 1.1 territorial gulls estimated visually to number of nests counted on the ground from Kadlec and Drury (1968).

colony is removed from the analysis it was estimated that mainland Nova Scotia had 16608 pairs of Great Black-backed Gulls and 11569 pairs of Herring Gulls in 1987 (A.R. Lock unpublished data) and 9547 pairs of Great Black-backed Gulls and 8720 pairs of Herring Gulls in 1971 (Lock 1971) (Figure 4). It should be acknowledged that correction factors are study and observer-specific and it is not necessarily appropriate to extrapolate between studies (Frederick et al. 2003). Therefore the estimates from 1971 and 1987 are rough estimates.

Using these estimates the breeding population of Great Black-backed Gulls in the portion of Nova Scotia we surveyed in 2002 increased from roughly 9500 pairs in 1971, to 16600 in 1987, and subsequently declined to 11400 pairs in 2002. Herring Gulls increased from 9000 in 1971 to 12000 in 1987 and have declined to 6400 in 2002. As mentioned above these trends need to be taken with limited confidence however, it seems that the number of nesting gulls in Nova Scotia has declined since 1987. Herring Gulls appear to have declined more than Great Black-backed Gulls which is similar to other surveys of gulls in New Brunswick (Boyne and Hudson 2002, Mawhinney et al. 1999), Prince Edward Island (Boyne et al. 2001), and Quebec (Chapdelaine 1995).

In 1971, our study area accounted for 62% of the entire provincial Great Black-backed Gull population of 15300 pairs and 61% of the Herring Gull population of 14200 pairs, while in 1987 this area accounted for 59% and 52% of the provincial total of Great Black-backed (28274 pairs) and Herring Gulls (22464 pairs), respectively. Based on these percentages, the provincial gull population in 2002 would be 18376-19310 pairs of Great Black-backed Gulls and 10548-12373 pairs of Herring Gulls.

The clutch sizes of Herring Gulls and Great Black-backed Gulls in this study were typical for the species (Good 1998, Pierotti and Good 1994), which may indicate that declines in the species are slowing down or that declines are not driven by poor food availability early in the breeding season. In the early 1990s, during a period when capelin (*Mallotus villosus*), an important forage fish, moved inshore later than usual and were not available to Herring Gulls early in the breeding season (Rodway and Regehr 1999) and a moratorium on the groundfish fisheries was implemented, Herring Gulls in Newfoundland produced clutches of 1.82 - 2.14 eggs per nest (Robertson et al. 2001); well below typical clutch sizes for the species (see also Boyne et al. 1999). In 1999 and 2000, the timing of the inshore migration of capelin had returned to normal as did the clutch size of Herring Gulls (Robertson et al. 2001). The fact that clutch sizes were typical in our study provides some evidence for the health of the populations, however food availability during chick-rearing and over-winter survival undoubtedly play a role in regulating the populations.

Cormorants

We estimate that 6349 pairs (5360-7337: 95% CI) of cormorants nested at 45 sites on mainland Nova Scotia in 2002. We could not identify cormorants to species (i.e. Double-crested Cormorant or Great Cormorant) because estimates were made from the air. Eight

colonies were photographed and one colony was visited by a survey crew carrying out nest counts (Table 5). Of the eight colonies that were photographed, visual estimates were not attempted at two sites, and observers clearly overlooked the majority of nests at two sites (i.e. Thrumcap Island and Pomquet Island; Table 5). Thus a correction factor was developed from four photographed colonies and one visited colony. The correction factor was 1.25 (0.97-1.53: 95% CI) nests for each *apparently occupied nest* estimated visually. To determine the number of pairs we used the number of *apparently occupied nests* from photo or ground counts if they were available, otherwise the correction factor was applied to the visual estimates. If visual estimates for a colony were made by both observers the correction factor was applied to the mean of the two estimates.

Calculation of correction factor for cormorant colonies.

Colony	Estimate of apparently occupied nests		Correction
	Photo/ ground	Visual	
Boot Island	260*	225	1.16
Ram Island	390	230	1.70
Blanche Island	219	225	0.97
Gull Rock, Clam Bay	77	55	1.40
Chockle Cap	75	74	1.02
		Mean	1.25
		95% CI	0.28

* ground count

In 1982, there were an estimated 7400 pairs of cormorants nesting in 37 colonies along the Atlantic coast of mainland Nova Scotia, of which around 500 pairs were Great Cormorants (Lock et al. 1983). This was more than double the 2800-3000 pairs of Double-crested Cormorants and 300 pairs of Great Cormorants estimated from 22 colonies in 1971 (Lock and Ross 1973). In 2002, along this same stretch of coast we identified 42 colonies and 5288 pairs (4299-6276: 95% CI) of cormorants (Boot, Amet, and Pomquet Islands which are located along the Northumberland Strait are subtracted from our totals). It appears that the cormorant population declined between 1982 and 2002, although the distribution and number of colonies are relatively unchanged (Figure 5; Lock et al. 1983). It should be noted that comparing these surveys is complicated by differences in methodologies. In 1982 estimates were derived mainly from nest counts conducted during visits to the colonies, whereas the majority of our estimates were based on corrected aerial surveys. We also were not able to differentiate between Great and Double-crested Cormorants.

Common Eider

While conducting ground surveys for gulls we counted 495 Common Eider nests on four islands, 4-5 June. The mean clutch size was 3.30 ± 1.20 and 0-27 % of the nests had hatched (Table 6). There were large gull colonies on all these colonies which may explain the low clutch size, which is typically 3.5-4.4 (Goudie et al. 2000).

Great Blue Herons

Aerial photos were taken of two Great Blue Heron colonies, one was estimated visually, and a ground count was completed at another (Table 7). Great Blue Heron colonies were previously known from Boot Island, Pomquet Island and Big Halibut Island but this was the first record for Bickerton Island. All three of the known colonies had increased since 1987 (Lock 1988). Boot Island increased to 73 nests up from 32; Pomquet increased from 94 to 183, and Big Halibut Island increased from 8 to as many as 12 (Table 7). This was not a complete survey of Great Blue Heron colonies along this coast. Our survey was focused on islands without trees, as those are preferred for nesting by gulls. Therefore we would have missed the majority of Great Blue Heron colonies. In 1988, Lock (1988) identified 19 colonies along the Nova Scotian coast.

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Table 1. Number of individuals and corrected pairs of Herring and Great Black-backed Gulls estimated at colonies identified during an aerial survey of mainland Nova Scotia, 2002. Corrected pairs were calculated by multiplying Observer 1's aerial visual estimates by 1.31.

Location	Latitude	Longitude	Date	Aerial visual estimate (individuals)				Corrected pairs		
				Great Black-backed Gull		Herring Gull				
				Observer 1	Observer 2	Observer 1	Observer 2	GBBG	HERG	Total
Lunenburg County										
Wood Island, St. Margarets Bay	44.645	-63.956	23-May	1	1			1	0	1
Southwest Island	44.505	-63.996	23-May	135	135	3	3	177	4	181
Gravel Island	44.499	-64.035	23-May	60	63			79	0	79
Black Island, St. Margarets Bay	44.510	-64.028	23-May	16	12			21	0	21
Pearl Island	44.384	-64.051	23-May	260		40		341	52	393
Flat Island, Mahone Bay	44.424	-64.128	23-May	85	91	6	4	113	6	119
Grassy Island, Mahone Bay	44.444	-64.141	23-May	60	70	60	70	79	79	158
Star Island	44.463	-64.186	23-May			140	200	0	183	183
Saddle Island	44.533	-64.189	23-May	2	2			3	0	3
Quaker Island	44.516	-64.233	23-May	44	44			58	0	58
Westhaver Island	44.436	-64.338	23-May	1	1			1	0	1
Hobson's Nose Island	44.417	-64.233	23-May	10	12			13	0	13
Chockle Cap	44.407	-64.217	23-May	63	84	147	196	83	193	276
Little Duck Island	44.363	-64.182	23-May	50	20	45	35	55	69	124
Big Duck Island	44.340	-64.140	23-May	25	18	15		43	10	53
Cross Island	44.311	-64.176	23-May	102	112			134	0	134
West Ironbound Island	44.231	-64.274	23-May	100	120			131	0	131
Indian Island	44.164	-64.400	23-May	45	45	20	12	63	22	85
Queens County										
Toby Island	44.114	-64.525	23-May	45	35	20	20	57	29	86
Puddingpan Island	44.061	-64.563	23-May	16	15			21	0	21
Coffin Island	44.044	-64.630	23-May	70	65	45	40	92	58	150
Mink Island, Port Mouton	43.917	-64.825	23-May	7	7			9	0	9
Massacre Island	43.908	-64.802	23-May	8	8			10	0	10
Jackies Island	43.901	-64.782	23-May	17	20	5	5	23	6	29
Shelburne County										
Green Rock	43.757	-64.938	23-May	63	67	7	8	82	9	91
Ram Island	43.684	-65.031	23-May	280	260			367	0	367
Thrum Cap, Jordan Bay	43.697	-65.168	23-May	2	2	2	2	3	3	6
Blue Island	43.682	-65.176	23-May	15	25	1		20	1	21
Jordan Bay Gull Rock	43.668	-65.210	23-May	80	75			105	0	105
Grey Island	43.600	-65.300	23-May	200	200	300	300	262	393	655
Gull Rock	43.567	-65.317	23-May	18	30			24	0	24
Blanche Island	43.472	-65.397	23-May	280	395			367	0	367
Page Island	43.492	-65.451	23-May	30	25			39	0	39
Little Stoney Island	43.461	-65.559	23-May	40	45			52	0	52
Cape Sable	43.397	-65.624	23-May	100		110		131	144	275
Fish Island, Cape Sable Island	43.425	-65.646	23-May	10		30		13	39	52
Cape Sable Island (Sandbar off)	43.408	-65.617	23-May	4				5	0	5
Georges Island	43.431	-65.624	23-May			50		0	66	66
Long Island, CSI	43.427	-65.627	23-May			100		0	131	131
Green Island, CSI	43.420	-65.677	23-May	64	148	16	37	84	21	105
Bear Point Thrums (Double Isl)	43.477	-65.674	23-May	75	110			98	0	98
Bear Point Thrums (Outer 3)	43.472	-65.673	23-May	155	120			203	0	203
Stoddart Island	43.473	-65.712	23-May			6	6	0	8	8
Outer Island	43.464	-65.745	23-May	500	550	50	110	628	93	721
Robinson Ball	43.502	-65.773	23-May	10	10			13	0	13
Ram Island	43.519	-65.777	23-May	5	5			7	0	7
Raspberry Island	43.509	-65.765	23-May	12	12			16	0	16
Goodwin Island	43.507	-65.776	23-May	5	5			7	0	7
Solomans Island	43.514	-65.761	23-May	10	10			13	0	13
Vigneau Island	43.531	-65.767	23-May	10	10			13	0	13
Vigneau Island, uni N of	43.533	-65.771	23-May	80	80			105	0	105
St. John's Island	43.551	-65.795	23-May	260	240	120	40	384	114	498
Digby County										
Peter Island	44.258	-66.339	23-May	32	54	128	216	42	168	210
Bear Island	44.629	-65.708	23-May	216	240	54	60	283	71	354
Annapolis County										
Goat Island	44.702	-65.609	23-May	25	25	75	75	33	98	131
Kings County										
Boot Island	45.144	-64.263	23-May	575	550			753	0	753

Location	Latitude	Longitude	Date	Aerial visual estimate (individuals)				Corrected pairs		
				Great Black-backed Gull		Herring Gull				
				Observer 1	Observer 2	Observer 1	Observer 2	GBBG	HERG	Total
Pictou County										
Amet Island	45.835	-63.179	24-May	11	16	60	65	16	77	93
Antigonish County										
Gooseberry Island	45.682	-61.888	24-May	58	65			76	0	76
Pomquet Island	45.656	-61.749	24-May	110	100	80	80	141	108	249
Perros Island	45.633	-61.639	24-May	60	65			79	0	79
Grahams Island	45.628	-61.636	24-May	30	30			39	0	39
Ile aux Morts	45.628	-61.634	24-May	20	30			26	0	26
Myettes Island	45.624	-61.631	24-May	100	110			131	0	131
Guysborough County										
Rook Island	45.348	-61.272	24-May	52	57			68	0	68
Half Island	45.354	-61.209	24-May	28	30	42	45	37	55	92
Flag Island	45.354	-61.016	24-May	110	160			144	0	144
Bull Head	45.351	-60.963	24-May	34	38			45	0	45
Walsh Island	45.351	-60.977	24-May	5	5			7	0	7
Derabie Island	45.353	-60.957	24-May	85	110			111	0	111
Derabies Island, uni northwest	45.353	-60.963	24-May	24	28			31	0	31
Cranberry Island North	45.329	-60.929	24-May	38	30			50	0	50
Cranberry Island South	45.325	-60.928	24-May	8	8			10	0	10
Crow Island	45.344	-60.945	24-May	25	25			33	0	33
Gull Island, Canso	45.293	-60.945	24-May	13	13			17	0	17
Black Island	45.281	-60.963	24-May	4	4			5	0	5
Thrumcap Island	45.264	-60.980	24-May	4	4			5	0	5
Dover Bay, uni south	45.251	-60.996	24-May	4	3	7	7	5	10	15
Grass Island	45.275	-61.014	24-May	12	12			16	0	16
Millstone Island	45.201	-61.112	24-May	2	3			3	0	3
Three Top Island	45.208	-61.147	24-May	10	7			13	0	13
Doliver Island	45.213	-61.169	24-May	3	2	2		5	1	6
Harbour Ledge	45.227	-61.217	24-May	3	3			4	0	4
Cooks Island	45.219	-61.240	24-May	3	2			4	0	4
Sugar Harbour Island, East	45.222	-61.264	24-May	23	17			30	0	30
Middle Sugar Harbour Island	45.221	-61.270	24-May	12	21			16	0	16
Sugar Harbour Island, West	45.214	-61.274	24-May	16	16			21	0	21
Forster, largest island W of	45.241	-61.342	24-May	1	1			1	0	1
Thrumcap Island	45.155	-61.517	24-May	13	7	3	7	14	7	21
Goose Island	45.117	-61.583	24-May	3	3			4	0	4
Harbour Island	45.130	-61.602	24-May	100		70		131	92	223
Bickerton Island	45.083	-61.717	24-May	18	18	1	1	24	1	25
Walter Island	45.067	-61.817	24-May	15	15	80	70	21	104	125
Wedge Island, Liscomb Hbr	45.007	-61.871	24-May	5	7	26	28	7	33	40
Tobacco Island	45.023	-61.912	24-May	17	5			22	0	22
Thrumcap Island	44.957	-62.040	24-May	6	8			8	0	8
Gull Ledge	44.911	-62.035	24-May	2	2			3	0	3
Halifax County										
Little White Island	44.894	-62.101	24-May	30	37			39	0	39
White Island, Big, main sect.	44.885	-62.129	24-May	21				28	0	28
Long Island, White Islands	44.884	-62.138	24-May	40	50			52	0	52
Camp Island	44.882	-62.157	24-May	35	40	10	20	43	16	59
Middle Halibut Island	44.899	-62.200	24-May	2	2	8	8	3	10	13
Little Halibut Island	44.901	-62.201	24-May	12	15			16	0	16
Tomahawk Island	44.920	-62.186	24-May	5	6			7	0	7
Gold Island	44.907	-62.259	24-May	15	16			20	0	20
Goose Island	44.888	-62.291	24-May	2	2			3	0	3
Bird Islands, inner west	44.867	-62.282	24-May	4	6			5	0	5
Bird Islands, outer east	44.866	-62.277	24-May	15	14			20	0	20
Sandy Island	44.883	-62.382	24-May	30	27	35	35	38	47	85
Horse Island, uni SE of	44.834	-62.354	24-May	3	3			4	0	4
Beaver Island	44.817	-62.333	24-May	17	15	30	24	23	39	62
Brother Islands East	44.824	-62.357	24-May	4	8	3	3	6	3	9
Brother Islands West	44.823	-62.363	24-May	9	25		3	11	1	12
Pumpkin Island	44.822	-62.380	24-May	40	50			52	0	52
Speck Island	44.842	-62.393	24-May	28	20			37	0	37
Hardwood Island, Sheet Hbr	44.836	-62.433	24-May	7	6			9	0	9
Sheet Rock	44.831	-62.491	24-May	10	7			13	0	13
Little Guilford Island, North	44.814	-62.517	24-May	13	16			17	0	17
Green Island, Taylors Head	44.821	-62.581	24-May	40	42			52	0	52
Leslie Island	44.817	-62.583	24-May	4	8			5	0	5
Fishermans Point	44.763	-62.658	24-May	52	35			68	0	68
Little Frair	44.727	-62.781	24-May	4	5			5	0	5
Cutfinger Island	44.704	-62.812	24-May	18	13			24	0	24
Bald Island	44.693	-62.809	24-May	19	33			25	0	25

Location	Latitude	Longitude	Date	Aerial visual estimate (individuals)				Corrected pairs		
				Great Black-backed Gull		Herring Gull				
				Observer 1	Observer 2	Observer 1	Observer 2	GBBG	HERG	Total
Halifax County (cont'd)										
Egg Island	44.663	-62.865	24-May	14	24	6	6	20	7	27
Goose Island	44.693	-62.889	24-May	21	29			28	0	28
Sugarloaf	44.705	-62.894	24-May	7	7	4	7	8	6	14
Duck Island	44.702	-62.937	24-May	65	65		17	76	9	85
Roger Islet	44.694	-62.981	24-May	20	25	10	18	25	15	40
Gull Rock, Clam Bay	44.674	-62.982	24-May	45	45	15	28	54	25	79
Wedge Island, Three Fathom	44.630	-63.268	24-May	10	10	160	165	13	210	223
Rat Rock	44.628	-63.269	24-May	10	10	15	25	11	22	33
Shut-in Island	44.619	-63.276	24-May	110	80	30	20	145	38	183
Devils Island	44.582	-63.459	23-May	60	75	540	675	79	707	786
Sambro Island	44.437	-63.563	23-May	135	117	15	13	177	20	197
Sambro Island, unnamed W of	44.436	-63.570	23-May	25	35			33	0	33
Sambro Island, Inner	44.454	-63.588	23-May	35	45			46	0	46
Thrumcap	44.460	-63.647	23-May	19	15			25	0	25
Pennant Island	44.451	-63.663	23-May	200	170			262	0	262
Mackerel Island	44.461	-63.678	23-May	15	15			20	0	20
Woody Island	44.449	-63.714	23-May	50	55	50	55	66	66	132
Lower Woody Island	44.445	-63.721	23-May	2	2			3	0	3
Ball Rock	44.453	-63.743	23-May	10	12			13	0	13
Betty Island	44.444	-63.764	23-May	13	10			17	0	17
Duck Island	44.450	-63.775	23-May	110	100			144	0	144
Hopson Island	44.451	-63.786	23-May	80	50			105	0	105
Gull Island, Outer	44.487	-63.824	23-May	60	70			79	0	79
Flemming Island	44.482	-63.856	23-May	17	32			22	0	22
Dover Island	44.482	-63.867	23-May	35	35			46	0	46
Moores Island	44.482	-63.859	23-May	8	8			10	0	10
Myers Island	44.483	-63.862	23-May	7	7			9	0	9
Indian Island, West Dover	44.487	-63.886	23-May	20	20			26	0	26
Jacks Island	44.517	-63.941	23-May	5	3			7	0	7
Shut-in Island	44.547	-63.957	23-May	65	48			85	0	85
Lukes Island	44.577	-63.940	23-May			1	1	0	1	1
Wedge Island	44.610	-63.948	23-May	25	30	75	100	31	100	131
Sheep Island, St. Margarets Bay	44.633	-63.945	23-May			1	1	0	1	1
Yarmouth County										
Green Island	43.694	-66.144	11-Jun	90	50	270	160	115	357	472
Reef Island	43.725	-66.087	11-Jun	60		330	250	39	472	511
Ram Island, Little River Hbr	43.702	-66.045	11-Jun	200	145	200	145	262	262	524
Murder Island	43.673	-66.057	11-Jun	12		33	55	8	51	59
Murder Island, uni SE of	43.670	-66.051	11-Jun	2		5		3	7	10
Ellenwoods Island	43.648	-66.054	11-Jun	2	4			3	0	3
Marks Island	43.634	-66.042	11-Jun	2	2	420	380	3	550	553
Peases Island	43.629	-66.028	11-Jun	5	5	25	15	8	31	39
Little Bald Tusket Island	43.619	-66.024	11-Jun	18	15			24	0	24
Inner Bald Tusket Island	43.610	-66.024	11-Jun	30		65	65	20	105	125
Bald Tusket Island	43.600	-66.028	11-Jun	21	15			28	0	28
Half Bald Tusket Island	43.619	-66.038	11-Jun	21	25			28	0	28
Little Half Bald Tusket Island	43.622	-66.029	11-Jun	10	9	3	3	13	4	17
Spectacle Island	43.632	-66.061	11-Jun	4	6	16	16	6	20	26
Holmes Island	43.641	-66.062	11-Jun	32	24	8	6	42	10	52
Green Island Ledge	43.661	-65.999	11-Jun	1		1		1	1	2
Green Island, Lobster Bay	43.667	-66.003	11-Jun	1				1	0	1
Bar Island, Western	43.676	-65.975	11-Jun	55	90	10	10	74	11	85
Little Fish Island	43.697	-65.945	11-Jun	42	45			55	0	55
Fish Island, Inner	43.701	-65.944	11-Jun	80	80			105	0	105
Gooseberry Island, Lobster Bay	43.688	-65.932	11-Jun	78	110			102	0	102
Gull Island	43.660	-65.916	11-Jun	50	85	10		72	7	79
East Money Island	43.690	-65.908	11-Jun	50	90	30		85	20	105
Whitehead Island, Lobster Bay	43.663	-65.867	11-Jun	5		70	120	3	95	98
Pumpkin Island	43.677	-65.867	11-Jun	25		100	140	16	147	163
The Thrum	43.683	-65.867	11-Jun	5		25	25	3	36	39
Lears Island	43.700	-65.865	11-Jun	270	230	40		380	26	406
Little Gooseberry Island	43.705	-65.859	11-Jun	120	140			157	0	157
Jones Island	43.692	-65.884	11-Jun	2	2			3	0	3
Ram Island	43.681	-65.842	11-Jun	120	120			157	0	157
Big Gooseberry Island	43.701	-65.833	11-Jun	55	55	15	15	72	20	92
Canoe Island	43.666	-65.833	11-Jun	20		220	360	13	301	314
			Totals	8730	8450	4870	4731	11393	6434	17827
			# of Colonies					182	78	188

Table 2. Correction factors for gull colonies surveyed in mainland Nova Scotia, 2002.

Location	Estimates				Corrections				
	Ground count (nests)	Aerial photo estimate (territories)	Aerial visual estimate – observer 1 (individuals)	Aerial visual estimate – observer 2 (individuals)	Photo estimate/ ground count	Ground count/ Obs. 1	Ground count/ Obs. 2	Photo estimate / Obs. 1	photo estimate/ Obs. 2
Boot Island	854		575	550		1.49	1.55		
Gooseberry Island, Antigonish Hbr	57		58	65		0.98	0.88		
Grahams Island	35		30	30		1.17	1.17		
Ile aux Morts	26		20	30		1.30	0.87		
Jacks Island *	46		5	3		9.20	15.33		
Myettes Island	164		100	110		1.64	1.49		
Rat Rock	35		25	35		1.40	1.00		
Wedge Island, Three Fathom	215		170	175		1.26	1.23		
Devils Island	724	1417	600	750	1.96	1.21	0.97	2.36	1.89
Shut-in Island	194	196	140	100	1.01	1.39	1.94	1.40	1.96
Perros Island	78	61	60	65	0.78	1.30	1.20	1.02	0.94
Woody Island		171	100	110				1.71	1.55
Thrumcap Island		18	16	14				1.13	1.29
Sambro Island		213	150	130				1.42	1.64
Ram Island		392	280	260				1.40	1.51
Pomquet Island		153	190	180				0.81	0.85
Peter Island		353	160	270				2.21	1.31
Pearl Island		346	300					1.15	
Gull Rock, Clam Bay		83	60	73				1.38	1.14
Grassy Island, Mahone Bay		89	120	140				0.74	0.64
Chockle Cap		262	210	280				1.25	0.94
Blanche Island		571	280	395				2.04	1.45
Amet Island		70	71	81				0.99	0.86
				n	3	10	10	15	14
				mean	1.25	1.31	1.23	1.40	1.28
				sd	0.62	0.18	0.34	0.49	0.41
				CI (95%)	0.71	0.11	0.21	0.25	0.21

* Jacks Island is not included in the analyses because the aerial visual estimates are so inaccurate that they can not be explained simply by estimation biases.

Table 3a. Clutch size and nest counts of Great Black-backed Gulls at colonies visited in Nova Scotia, 2002

Location	Latitude	Longitude	Date	Number of nests with					Nests with eggs	Chicks hatched	Clutch size	
				0 eggs	1 egg	2 eggs	3 eggs	4 eggs			Mean	S.D.
Boot Island	45.144	-64.263	16 May	137	81	184	561	1	827	91	2.58	0.66
Grahams Island	45.628	-61.636	31 May	5	4	11	20	0	35	61	2.46	0.70
Ile aux Morts	45.628	-61.634	31 May	7	1	9	16	0	26	32	2.58	0.58
			Totals	149	86	204	597	1	888	184	2.58	0.66

Table 3b. Number of nests, chicks, and eggs of Great Black-backed Gulls at colonies where the age of the chicks made it impossible to identify their nest of origin.

Location	Latitude	Longitude	Date	Eggs	Chicks	Total chicks and eggs	Nests	Percent hatch
Perros Island	45.633	-61.639	31 May	93	61	154	77	40%
Myettes Island	45.624	-61.631	31 May	168	140	308	164	45%
Gooseberry Island	45.682	-61.888	1 June	60	39	99	57	39%
Jacks Island	44.517	-63.941	3 June	64	38	102	46	37%
Wedge Island, Three Fathom*	44.63	-62.268	4 June	3	-	-	2	-
Rat Rock	44.628	-63.269	4 June	46	37	83	32	45%
Shut-in Island	44.619	-63.276	4 June	230	144	374	177	39%
Devils Island	44.582	-63.459	5 June	150	105	255	128	41%
			Totals	811	564	1375	681	41%

* Not included in totals because nests contained cold eggs and may have had additional chicks that were not found.

Table 4. Clutch size and nest counts of Herring Gulls at colonies visited in Nova Scotia, 2002.

Location	Latitude	Longitude	Date	Number of nests with					Nests with eggs	Chicks hatched	Clutch size	
				0 eggs	1 egg	2 eggs	3 eggs	4 eggs			Mean	S.D.
Boot Island	45.144	-64.263	16 May	6	10	9	8	0	27	1	1.93	0.83
Perros Island	45.633	-61.639	31 May	0	1	0	0	0	1	0	1.00	-
Wedge Island, Three Fathom	44.630	-62.268	4 June	5	8	36	165	4	213	0	2.77	0.54
Rat Rock	44.628	-63.269	4 June	0	0	1	2	0	3	0	2.67	0.58
Shut-in Island	44.619	-63.276	4 June	0	1	5	10	1	17	0	2.65	0.70
Devils Island	44.582	-63.459	5 June	60	32	106	457	1	596	85	2.72	0.56
			Totals	71	52	157	642	6	857	86	2.70	0.59

Table 5. Estimates of cormorant pairs at colonies surveyed in mainland Nova Scotia, 2002.

	Location	Latitude	Longitude	Date	Estimate of apparently occupied nests			Pairs*
					Visual -Boyne	Visual - Lock	Photo	
	Halifax County							
1	Thrumcap	44.460	-63.647	23 May		4		5
2	Mackerel Island	44.461	-63.678	23 May	175	220		247
3	Gull Island, Inner	44.492	-63.817	23 May	52	30		51
4	Gull Island, Outer	44.487	-63.824	23 May	3	3		4
5	Wedge Island	44.610	-63.948	23 May	50	30		50
	Lunenburg County							
6	Horse Island	44.533	-64.013	23 May	175	250		266
7	Saddle Island	44.533	-64.189	23 May	70			88
8	Hobson's Nose Island	44.417	-64.233	23 May	20	12		20
9	Chockle Cap	44.407	-64.217	23 May	63	84	75	75
10	Big Duck Island	44.340	-64.140	23 May	150			188
11	Foggy Island	44.233	-64.283	23 May	150	140		181
12	Indian Island	44.164	-64.400	23 May	60	55		72
	Queens County							
13	Puddingpan Island	44.061	-64.563	23 May	5	5		6
14	Massacre Island	43.908	-64.802	23 May	110	70		113
	Shelburne County							
15	Green Rock	43.757	-64.938	23 May	70	70		88
16	Ram Island	43.684	-65.031	23 May		230	390	390
17	Thrum Cap, Jordan Bay	43.697	-65.168	23 May	2	2		3
18	Blue Gull Island	43.670	-65.210	23 May	280	360		400
19	Gull Rock	43.567	-65.317	23 May	125	180		191
20	Blanche Island	43.472	-65.397	23 May	225		219	219
21	Little Stoney Island	43.461	-65.559	23 May	40	60		63
22	Bear Point Thrums	43.472	-65.673	23 May	220			275
23	Ram Island	43.519	-65.777	23 May	80	75		97
24	East Money Island	43.690	-65.908	23 May	80			100
25	Gooseberry Island	43.688	-65.932	23 May	20			25
26	Fish Island, Inner	43.701	-65.944	23 May	55			69
27	Little Fish Island	43.697	-65.945	23 May	180			225
	Kings County							
28	Boot Island	45.144	-64.263	23 May	250	200	260 [1]	260
	Cumberland							
29	Amet Island	45.835	-63.179	24 May			325	325
	Antigonish County							
30	Pomquet Island	45.656	-61.749	24 May		6	476	476
	Guysborough County							
31	Crow Island	45.344	-60.945	24 May	200	200		250
32	Black Island	45.281	-60.963	24 May	110	125		147
33	Sugar Harbour Island, West	45.214	-61.274	24 May	240			300
34	Thrumcap Island	45.155	-61.517	24 May	3	7	105	105
35	Tobacco Island	45.023	-61.912	24 May	95			119
36	Gull Ledge	44.911	-62.035	24 May	90	110		125
	Halifax County (cont'd)							
37	Little White Island	44.894	-62.101	24 May	50	28		49
38	Middle Halibut Island	44.899	-62.200	24 May		160		200
39	Brother Islands West	44.823	-62.363	24 May	40			50
40	Speck Island	44.842	-62.393	24 May	110			138
41	Little Guilford Island, Middle	44.812	-62.515	24 May	50			63
42	Little Guilford Island, South	44.811	-62.513	24 May	80			100
43	Leslie Island	44.817	-62.583	24 May	40			50
44	Gull Rock, Clam Bay	44.674	-62.982	24 May		55	77	77
45	Shut-in Island	44.619	-63.276	24 May			9	9
							Total	6370

* To determine the number of pairs we used the number of apparently occupied nests from photo or ground counts if they were available, otherwise a correction factor (1.25) was applied to the visual estimates. If two visual estimates were available for a colony the correction factor was applied to the mean of the two.

[1] ground survey (C. M. MacKinnon)

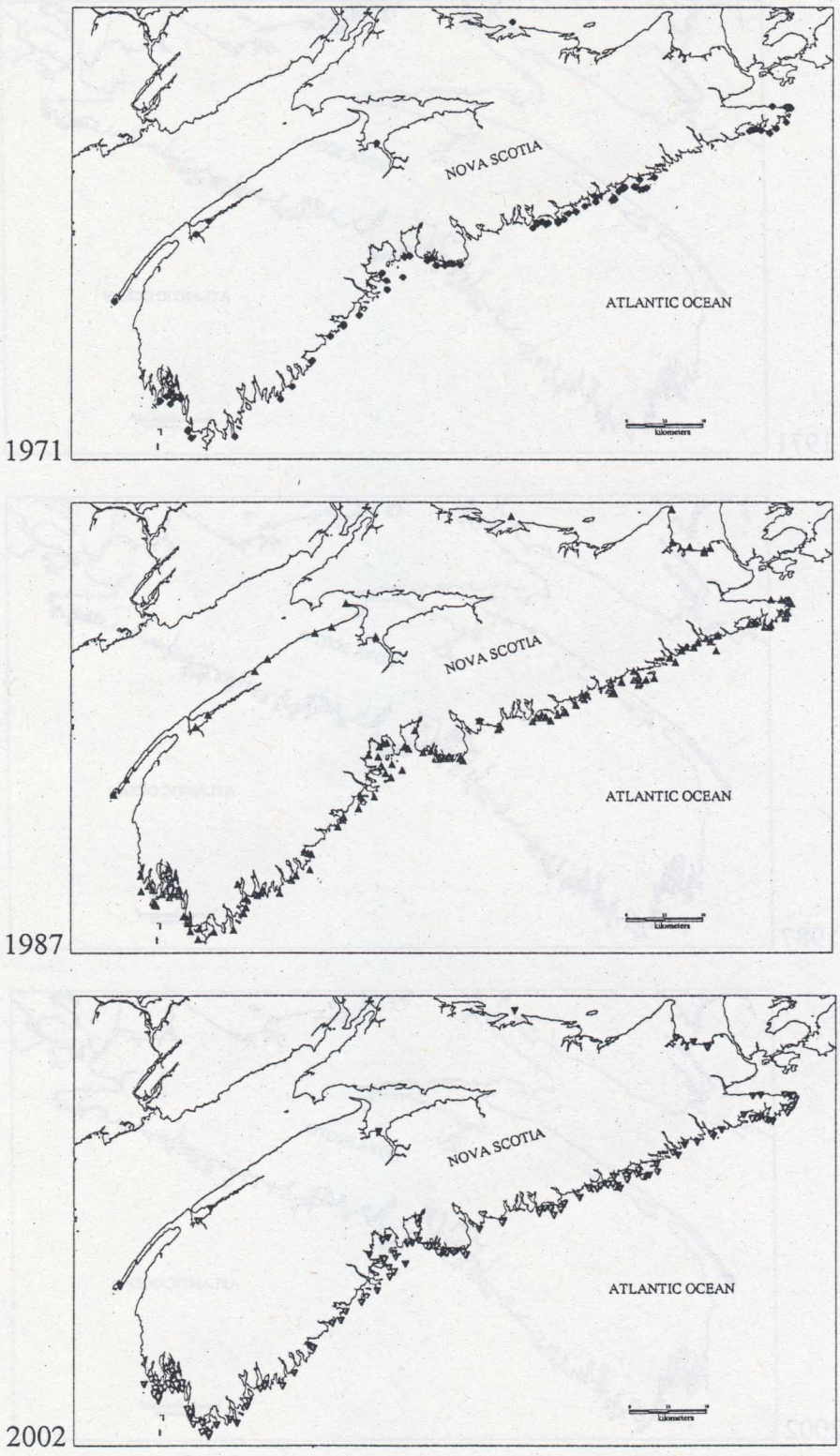

Figure 2. Distribution of Great Black-backed Gull colonies on mainland Nova Scotia in 1971 (Lock 1971), 1987 (Lock, unpublished data), and 2002.

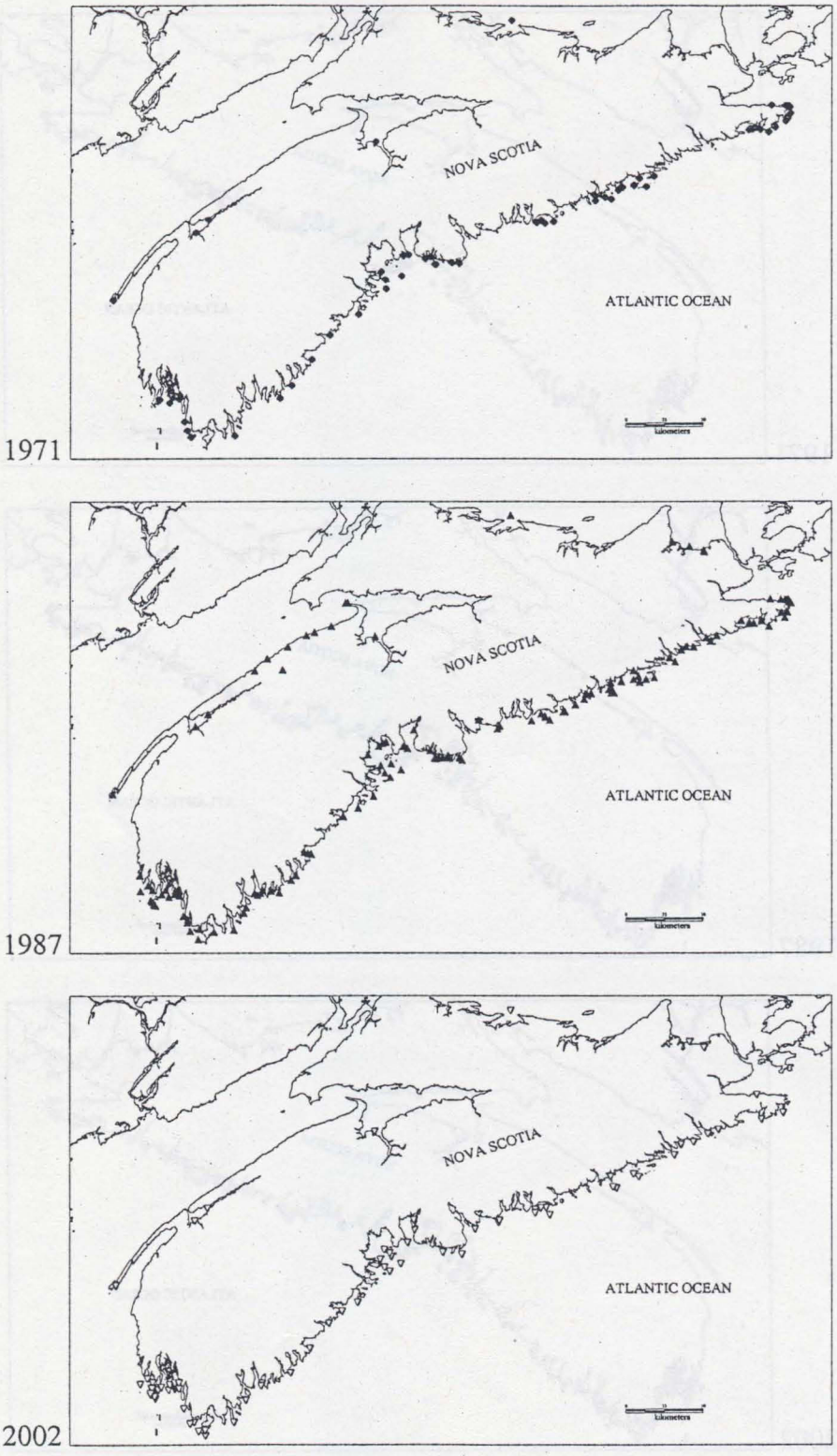

Figure 3. Distribution of Herring Gull colonies on mainland Nova Scotia in 1971 (Lock 1971), 1987 (Lock, unpublished data), and 2002.

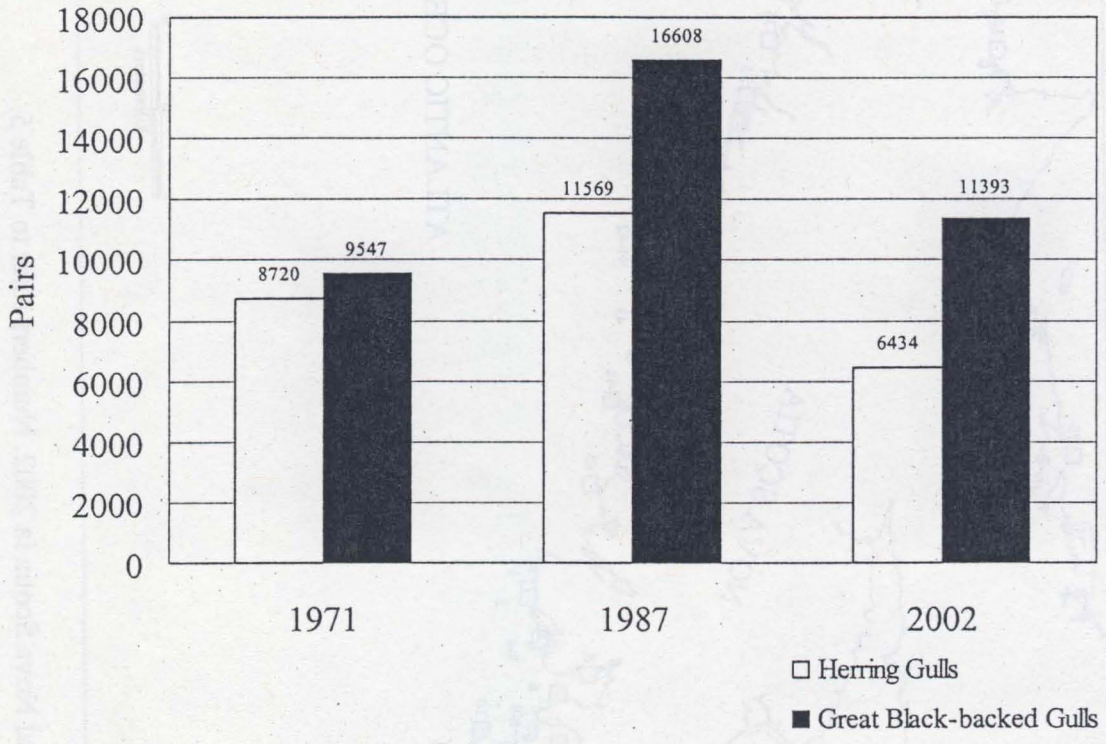

Figure 4. Number of pairs of Great Black-backed Gulls and Herring Gulls in Nova Scotia in the 2002 study area in 1971 (Lock 1971), 1987 (Lock, unpublished data), and 2002.

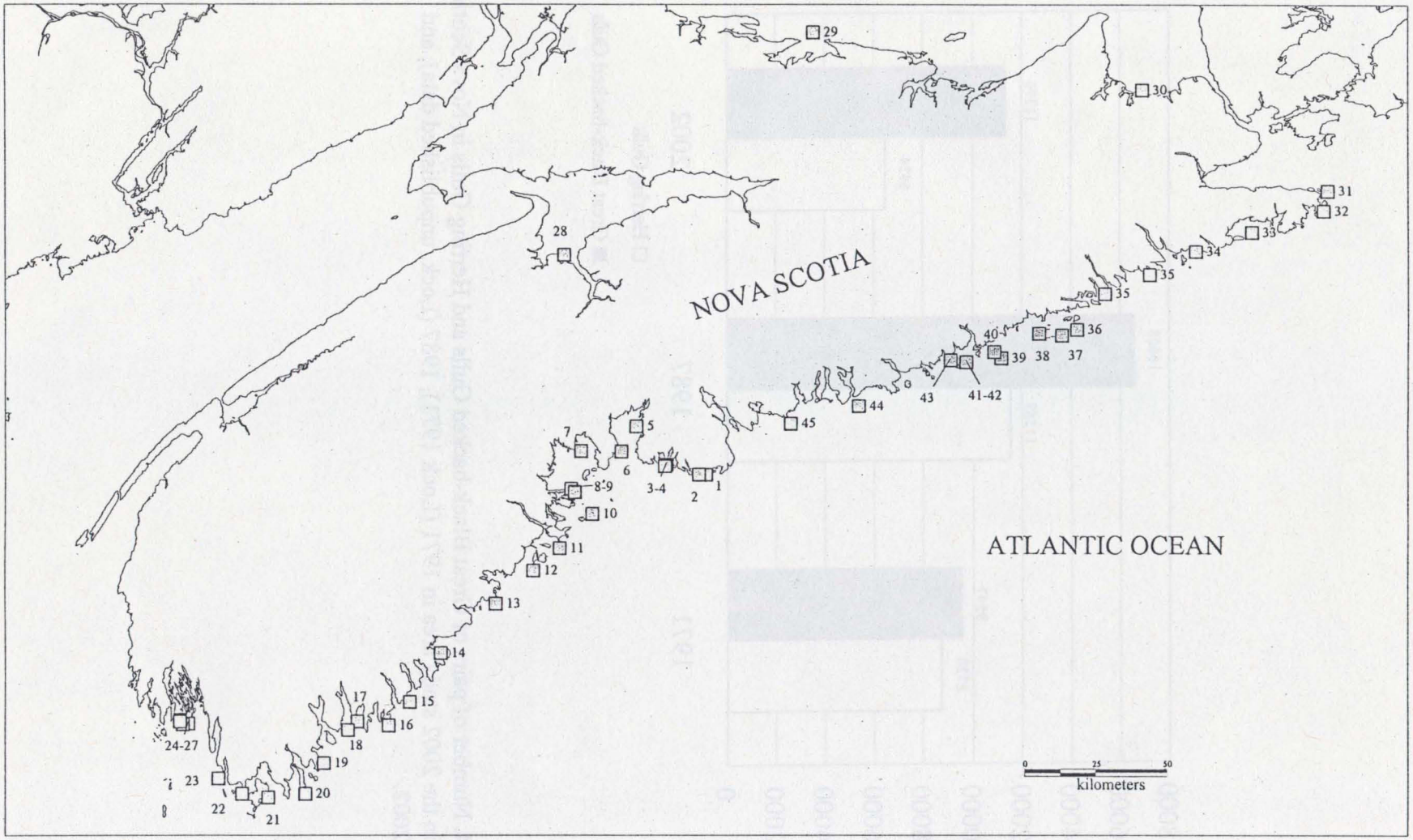

Figure 5. Distribution of cormorant colonies on mainland Nova Scotia in 2002. Numbers refer to Table 5.

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